MODELING DRIVERS’ STATED ENROUTE SWITCHING BEHAVIOR UNDER VARIOUS INFORMATION SCENARIOS

Cheng-Min FENG
Professor
Institute of Traffic and Transportation
National Chiao Tung University
4F, 114 Sec. 1, Chung-Hsiao W. Rd., Taipei 10012 Taiwan
Fax: +886-2-2349-4965
E-mail: cmfeng@mail.nctu.edu.tw

Yi-Wen KUO
Assistant Professor
Department of Transportation and Logistics
TOKO University
51 Sec. 2, University Rd., Puzih City, Chiayi 61363 Taiwan
Fax: +886-5-362-1990
E-mail: shauai@pchome.com.tw

Abstract: Advanced Driver Information Systems can benefit drivers by switching routes while encountering traffic congestion to alleviate congestion. Therefore, it is important to realize the latent variables of real-time traffic information that affect drivers’ enroute switching behavior. This paper identified the latent variables that will positively or negatively affect drivers’ enroute switching behavior and explored the causal effect by applying structural equation modeling. Then binary logit model was used to confirm whether latent variables and information scenarios will affect drivers’ enroute switching behavior. Empirical findings indicate that the latent variables of perceived value, usage attitude and compliance rate toward traffic information would positively enhance freeway drivers’ enroute switching rates, but switching barrier and congestion tolerability would largely impede them in the case of Taiwan. However, providing more detailed information on alternative routes can motivate drivers’ enroute switching behavior during traffic congestion.

Key Words: enroute switching behavior, structural equation model, binary logit model

1. INTRODUCTION

Since the traffic situation is worsening, methods for reducing traffic congestion have been issued recently. Advanced Driver Information Systems (ADIS) have been considered to improve network performance efficiency by offering real-time traffic information to drivers. The provision of real-time traffic information is a key determinant mechanism of ADIS. It may affect drivers’ travel decisions, such as enroute diversion, route selection, and departure time decisions (Madanat et al., 1995). Thus, means of providing drivers with real-time traffic information to influence their driving behavior has gained much attention.

Previous studies often incorporate quantitative factors rather than qualitative factors into route-choice models, so that the predictive ability might be queried. In order to enable the models to be more representative of drivers’ behavior and improve the explanatory and predicting ability, latent variables have recently been considered in the behavioral model. In addition to the socioeconomic characteristics, relevant studies found other significant latent variables which may affect the enroute switching behavior of drivers, such as their perceptions on the reliability of traffic information, their attitudes in complying with
information suggestions and various types of real-time traffic information (Madanat et al., 1995; Ng et al., 1995; Emmerink et al., 1996; Jou et al., 1997; Chen et al., 1999; Abdel-Aty and Abdalla, 2004; Jou et al., 2004; Jou et al., 2005; Feng and Kuo, 2007).

However, studies focusing on drivers’ enroute switching behavior might not discuss the effects on positive and negative aspects simultaneously in the past. For the sake of realizing drivers’ enroute behavior more explicit, this paper will focus both on positive variables (such as perceived value, usage attitude, and compliance rate) and negative variables (such as switching barrier and congestion tolerability). Moreover, this paper will explore drivers’ stated enroute switching behavior under various information scenarios. Therefore, this paper proposes an analysis framework to incorporate latent variables, socioeconomic and travel characteristics in the model under various information scenarios to explain drivers’ stated enroute switching behavior.

2. RESEARCH BACKGROUND

2.1 Development of the ADIS in Taiwan

Many researchers have indicated that the provision of real-time traffic information can effectively improve network performance and service quality (Mahmassani and Liu, 1999; Abdel-Aty and Abdalla, 2004). The results from these studies show that the drivers’ enroute switching intention can be stimulated by the provision of real-time information. Thus, ADIS has recently been used as the means to alleviate traffic congestion by providing real-time information to drivers for changing their enroute decisions.

However, the benefits of ADIS are achieved only if the drivers respond to the real-time traffic information in a positive manner. Hence, the effectiveness of real-time traffic information greatly depends on the drivers’ acceptance and compliance toward it. This is the critical factor for successful implementation of ADIS. Moreover, which types of real-time traffic information should be provided is also crucial to drivers’ enroute switching behavior.

Although real-time traffic information plays a vital role in the enroute decision of drivers, the development of technologies for traffic data collection is still in its infancy in Taiwan. Contents of real-time traffic information are always provided based on the traffic manager’s viewpoint, and they may not suitable for the real demand of drivers at present. A better understanding of drivers’ enroute switching intention and behavior may help the traffic manager to improve the content of real-time traffic information. Drivers’ perceptions, attitudes, and preferences toward information should be taken into careful consideration in the
revision of information contents. Less research has provided real-time information content based on drivers’ standpoints even though they are the key determinants of the behavioral response of drivers.

In the future, the application of several technologies such as probe vehicle, electronic toll collection (ETC), and vehicle position system (VPS) will be applied to broadcast traffic data collection along the freeway in Taiwan. More and more precise and useful traffic information would be extracted from the process of data mining. Information quality may have a significant effect on drivers’ enroute switching behavior. For the congestion management purpose, how to provide real-time traffic information from the drivers’ point of view should be of great concern. According to the exploration of drivers’ demand, the design of better traffic information contents would be beneficial for the development of ADIS.

2.2 Literature Review

In order to enhance the explanatory and predictive ability of the travel behavior model, researchers recently considered the latent variables concerning drivers’ perceptions and attitudes into the model (Adler et al., 1994; Madanat et al., 1995; Abdel-Aty et al., 1997; Jou et al., 2003; Tong et al., 2004; Feng and Kuo, 2007). Madanat et al. (1995) applied two latent variables (drivers’ attitudes toward route diversion and their perceptions of the reliability of information) to the models to determine the factors that affected drivers’ stated intentions to divert from their usual routes while encountering traffic congestion. Tong et al. (2004) explored the personal variation in response to various information strategies supplied by in-vehicle information devices, and extract each driver’s individual characteristics into two latent variables identified as “attitude” and “cognition” towards in-vehicle information.

Several surveys also indicated that drivers had higher intentions in switching routes when they received real-time information with more detailed descriptions such as delay situation and alternative routes guidance (Khattak, 1993; Jou et al., 1997; Jou et al., 2005; Feng and Kuo, 2007). Abdel-Aty et al. (1997) explored the factors that influence drivers’ route choice, including advanced traffic information with travel time estimates. Traffic information can help to reduce drivers’ uncertainty of travel time and to enable them to choose routes adaptively. Jou et al. (2005) investigated the route switching behavior on freeways in reaction to the provision of different types of real-time traffic information, and the route guidance and quantitative information were more preferable to drivers. Besides, drivers’ socioeconomic characteristics and personality would influence drivers’ enroute switching intentions (Khattak et al., 1993; Madanat et al., 1995).

Therefore, this paper will incorporate the significant factors that would play important role on
drivers’ enroute switching behavior into the model, such as latent variables (drivers’ perceptions and attitude toward traffic information and diversion), types of real-time traffic information, socioeconomic and travel characteristics etc. In addition to consider the positive effects on drivers’ enroute switching behavior, negative effects will be taken into account in the models. Switching barriers represent any factor which makes it more difficulty or costly for drivers in changing diversion decisions. For example, drivers may feel troublesome for searching alternative routes information or concern for uncertainty situation of alternative routes. Besides, drivers often tolerate the low speed and long queue while encountering traffic congestion on freeway due to their inherent patience and unadventurous. These negative concerns lead drivers always remain with their existing driving routes. Thus, the negative latent variables switching barrier (Jones, 2000; Feng and Kuo, 2007) and congestion tolerability will be incorporated into the behavioral model. Various hypothetic information scenarios will also be confirmed by their effects on the drivers’ switching decisions.

### 2.3 Research Problems

Even though drivers always receive real-time traffic information on the road, they may not comply with the enroute switching suggestion while encountering or anticipating a traffic jam. How does the driver react to the real-time traffic information? Based on the purpose of congestion management, it is necessary to explore drivers’ real opinions (including perceptions, attitudes, and preferences) toward the real-time traffic information they received. To facilitate ADIS development, we should provide drivers more applicable information to make them more acceptable of and compliant with real-time traffic information. Thus, the research issues have been proposed as follows:

- **Issue 1:** To explore the effects of latent variables (such as perceived value, usage attitude, switching barrier, and congestion tolerability etc.) on drivers’ compliance rate and their causal relationships while real-time traffic information given.
- **Issue 2:** To confirm whether latent variables and various traffic information scenarios will affect drivers’ stated enroute switching behavior.

### 3. ANALYSIS FRAMEWORK AND METHODOLOGY

#### 3.1 Analysis Framework and Hypotheses

In order to explore the effects of real-time traffic information on drivers’ enroute switching behavior, this paper proposes a two-stage analysis framework (Figure 1). Firstly, we shall extract which significant latent variables may influence drivers’ enroute switching intentions by using the structural equation modeling process. This process contributes to realize drivers’
real perceptions and attitudes toward the revealed traffic information and enroute switching behavior. We shall then explore the causal effects between these latent variables. The latent variables are supposed to comprise of drivers’ perceived value, usage attitude, switching barrier, and congestion tolerability, which may have positively or negatively influence their compliance rate, respectively.

Then, we should confirm whether latent variables and various scenarios of real-time traffic information would affect drivers’ stated enroute switching behavior. These latent variables were transferred into explanatory variables for drivers’ enroute switching behavior model. Latent variables will be taken as the input data to the following binary logit model. While drivers encounter different congestion conditions, their enroute switching decisions may be influenced by latent variables, socioeconomic and travel characteristics under various information scenarios.

As shown in Fig.1, we hypothesize that drivers’ compliance rate toward received traffic information may be affected by several latent variables as follows:

- $H_1$: Drivers’ perceived value is positively related to their usage attitude.
- $H_2$: Drivers’ usage attitude is positively related to their compliance rate.
- $H_3$: Drivers’ perceived value is positively related to their compliance rate.
- $H_4$: Drivers’ switching barrier is negatively related to their compliance rate.
- $H_5$: Drivers’ congestion tolerability is negatively related to their compliance rate.
3.2 Analysis Approach

The structure of the analysis approach and data flow is illustrated in Figure 2. The data used in this paper were collected through a questionnaire survey of drivers, and the information scenarios were designed using the stated preference method. Three categories of data included drivers’ perceptions and attitudes toward revealed traffic information, socioeconomic and travel characteristics, and stated switching behavior under various information scenarios. Then the data applied in two principal approaches: the structural equation model and binary logit model. Through the approach of the structural equation model, the manifest variables of drivers’ perceptions and attitudes can be transferred into latent variables as the input variables into binary logit model. In addition to the latent variables, stated switching behavior, socioeconomic and travel characteristics were also entered into the binary logit model as explanatory variables. Finally, drivers’ enroute switching behavior model on the freeway would be estimated.

![Figure 2 Analysis approach and data flow](image)

3.3 Structure Equation Model

The latent variables were analyzed using the SEM method in this paper. The structure equation model is composed of the measurement model and the structural model. The measurement model defines the relationship between the observed (manifest variables) and unobserved variables (latent variables) that influence the enroute switching intention. The structural model specifies the relationship between the latent variables. The general SEM equations can be expressed as follows:

The measurement model for the $x$-variables:  
$$ x = \Lambda_x \xi + \delta \quad (1) $$

The measurement model for the $y$-variables:  
$$ y = \Lambda_y \eta + \varepsilon \quad (2) $$
The structural model: \( \eta = B \eta + \Gamma \xi + \zeta \)  

where

\( x \) = the vector of observed exogenous variables;  
\( y \) = the vector of observed endogenous variables;  
\( \xi \) = the vector of exogenous latent variables;  
\( \eta \) = the vector of endogenous latent variables;  
\( \Lambda_x \) = the regression matrix that relates exogenous variables \( \xi \) to each of the observed exogenous variables;  
\( \Lambda_y \) = the regression matrix that relates endogenous variables \( \eta \) to each of the observed endogenous variables;  
\( \delta \) = the vector of error terms corresponding to \( x \);  
\( \epsilon \) = the vector of error terms corresponding to \( y \);  
\( \zeta \) = the vector of residuals representing errors and random disturbance terms;  
\( B \) = the matrix of coefficients that relates \( \eta \) variables to another one;  
\( \Gamma \) = the matrix of coefficients that relates \( \xi \) variables to \( \eta \) variables.

The \( x \) variables are regarded as the indicators for the explanatory latent variables \( \xi \), and the \( y \) variables are regarded as the indicators for the dependent latent variables \( \eta \). The elements of \( B \) represent the direct causal effects of \( \eta \) variables on another one, and the elements of \( \Gamma \) represent the direct causal effects of \( \xi \) variables on \( \eta \) variables. \( \epsilon \) is assumed to be uncorrelated with \( \eta \), and \( \delta \) and \( \zeta \) are assumed to be uncorrelated with \( \xi \).

### 3.4 Binary Logit Model

In this paper, the hypothetical information scenario questions were presented to the respondents to explore drivers’ stated enroute switching intention required simple binary responses of yes or no. Since the choice set contains exactly two choices, it is appropriate to use the binary logit model as an analysis tool in this situation. The model can be represented by the following equation:

\[
U = \alpha I + \beta M + \gamma N + v
\]  

\[
U^* = \begin{cases} 
1 & \text{if } U \geq 0 \\
0 & \text{otherwise} 
\end{cases}
\]

where

\( U \) = unobserved variable representing a driver’s enroute switching intention;  
\( U^* \) = observed choice (1 if the driver switches to the alternative route, 0 otherwise);  
\( I \) = the vector of dummy variables that represents hypothetical information scenarios provided to drivers;  
\( M \) = the vector of manifest variables including socioeconomic and travel characteristics;  
\( N \) = another vector of manifest variables;  
\( v \) = the error term.
N = the vector of latent variables extracted from SEM;
\( \alpha \) = the coefficient vector corresponding to \( \text{I} \);
\( \beta \) = the coefficient vector corresponding to \( \text{M} \);
\( \gamma \) = the coefficient vector corresponding to \( \text{N} \);
\( \nu \) = error term.

4. QUESTIONNAIRE SURVEY AND RESULTS

4.1 Questionnaire Design and Survey

The survey was based on data collected from an on-line questionnaire in Taipei metropolitan area in Taiwan with the objectives to analyze the behavioral impacts of real-time traffic information. The questionnaire consists of three parts: the socioeconomic and travel characteristics of drivers, perceptions and attitudes toward received real-time traffic information, and stated enroute switching behavior under various scenarios of real-time traffic information. The latent variables and observed variables in structural equation model of this study are summarized in Table 1. Five constructs (latent variables) and 13 items (observed variables) are hypothesized in the proposed structural equation model.

<table>
<thead>
<tr>
<th>Latent variable</th>
<th>Observed variable</th>
<th>Representation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Perceived value</td>
<td>( x_1 )</td>
<td>The traffic information content describes in detail.</td>
</tr>
<tr>
<td>( \xi_1 )</td>
<td>( x_2 )</td>
<td>The traffic information content can update real-time.</td>
</tr>
<tr>
<td></td>
<td>( x_3 )</td>
<td>The traffic information content is helpful to predict travel time.</td>
</tr>
<tr>
<td></td>
<td>( x_4 )</td>
<td>The traffic information content can express the guidance of alternative routes definitely.</td>
</tr>
<tr>
<td>Switching barrier</td>
<td>( x_5 )</td>
<td>I feel troublesome to search for alternative routes information.</td>
</tr>
<tr>
<td>( \xi_2 )</td>
<td>( x_6 )</td>
<td>Switching to alternative routes will waste time instead.</td>
</tr>
<tr>
<td>Congestion tolerability</td>
<td>( x_7 )</td>
<td>I can tolerate the low speed while encountering traffic jam.</td>
</tr>
<tr>
<td>( \xi_3 )</td>
<td>( x_8 )</td>
<td>I can tolerate the long queue while encountering traffic jam.</td>
</tr>
<tr>
<td>Usage attitude</td>
<td>( y_1 )</td>
<td>To receive real-time information is very important while driving on freeway.</td>
</tr>
<tr>
<td>( \eta_1 )</td>
<td>( y_2 )</td>
<td>As long as driving on freeway, I must receive real-time information.</td>
</tr>
<tr>
<td></td>
<td>( y_3 )</td>
<td>While encountering in traffic jam, I want to receive real-time information.</td>
</tr>
<tr>
<td>Compliance rate</td>
<td>( y_4 )</td>
<td>I often switch routes while receiving congestion information ahead.</td>
</tr>
<tr>
<td>( \eta_2 )</td>
<td>( y_5 )</td>
<td>I often switch routes while receiving route-switching suggestion.</td>
</tr>
</tbody>
</table>
To identify commuting characteristics, a stated trip purpose of working and the commuting network were assumed under the given information scenarios. The respondents were assumed to ride a car on the regular route from the origin location to the destination location, and receive real-time information content via radio traffic reports (RTRs). While receiving five hypothetical information scenarios as listed in Table 2, drivers’ should make decisions to switch to the alternative route or not. However, if most of drivers over react to the diversion suggestion, it may result in three negative impacts such as over-saturation, over-reaction and concentration (Ben-Akiva et al., 1991), which turn out unremarkable achievements of ADIS. For keeping from this controversy, we assume that the provision of traffic information would update real-time as soon as possible and consequently it may probably prevent too many vehicles from concentrating on the alternative route and resulting in worse situation.

As shown in Table 2, the content of information Scenario0 is relatively rough, and it only broadcasts the information of travel speed concerning the regular route. Then, more information richness on the regular and alternative route is gradually provided from Scenario0 to Scenario4. Thus, the content of Scenario4 is the most detailed, providing travel speed and travel time both on the regular route and the suggested alternative route.

<table>
<thead>
<tr>
<th>Information scenario</th>
<th>Information contents on the regular route</th>
<th>Information contents on the alternative route</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scenario 0</td>
<td>Travel speed</td>
<td>—</td>
</tr>
<tr>
<td>Scenario 1</td>
<td>Travel speed and travel time</td>
<td>—</td>
</tr>
<tr>
<td>Scenario 2</td>
<td>Travel speed</td>
<td>Switching suggestion</td>
</tr>
<tr>
<td>Scenario 3</td>
<td>Travel speed</td>
<td>Switching suggestion and travel speed</td>
</tr>
<tr>
<td>Scenario 4</td>
<td>Travel speed and travel time</td>
<td>Switching suggestion, travel speed and travel time</td>
</tr>
</tbody>
</table>

Respondents had to determine their likelihood of perceptions and attitudes toward the traffic information they had received on a five-point ordered scale. The responses were rated on a five-point Likert scale with a positive statement, and classified to five degrees as “strongly disagree”, “disagree”, “undecided”, “neutral”, and “strongly agree”. According to the drivers’ enroute switching behavior under hypothetical information scenarios, the respondents should decide whether they switch to the alternative route or not on binary choice.

4.2 Statistical Summary

A total of 493 valid questionnaires were returned during August in 2005. The survey characteristics are given in Table 2. More than sixty percent of the respondents are males,
between the ages of 25 and 44, college and graduate school, and most, personal incomes were between 20–60 thousand per month. Nearly half of the respondents are having at least 10 years driving experience. The percentage of trip purposes were recreational (29.28%), social (27.18%), working (22.92%), and business (20.08%) respectively. Besides, the percentage of the response toward respondents’ stated enroute switching behavior with different information scenarios were depicted in Figure 3. More than seventy percent of the respondents would likely to switch to the alternative route while receiving information Scenario3 or Scenario4.

Table 3 Characteristics distributions of respondents

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Samples</th>
<th>Distribution (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td></td>
<td></td>
</tr>
<tr>
<td>male</td>
<td>315</td>
<td>63.9</td>
</tr>
<tr>
<td>female</td>
<td>178</td>
<td>36.1</td>
</tr>
<tr>
<td>Age</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt; 24 years old</td>
<td>31</td>
<td>6.3</td>
</tr>
<tr>
<td>25 ~ 34 years old</td>
<td>220</td>
<td>44.6</td>
</tr>
<tr>
<td>35 ~ 44 years old</td>
<td>126</td>
<td>25.6</td>
</tr>
<tr>
<td>45 ~ 54 years old</td>
<td>49</td>
<td>9.9</td>
</tr>
<tr>
<td>55 ~ 64 years old</td>
<td>36</td>
<td>7.3</td>
</tr>
<tr>
<td>&gt; 65 years old</td>
<td>31</td>
<td>6.3</td>
</tr>
<tr>
<td>Education background</td>
<td></td>
<td></td>
</tr>
<tr>
<td>high-school</td>
<td>144</td>
<td>29.2</td>
</tr>
<tr>
<td>college</td>
<td>229</td>
<td>46.5</td>
</tr>
<tr>
<td>graduate school</td>
<td>120</td>
<td>24.3</td>
</tr>
<tr>
<td>Monthly income</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt; NT$ 20 thousands</td>
<td>46</td>
<td>9.3</td>
</tr>
<tr>
<td>NT$ 20 ~ 40 thousands</td>
<td>164</td>
<td>33.3</td>
</tr>
<tr>
<td>NT$ 40 ~ 60 thousands</td>
<td>172</td>
<td>34.0</td>
</tr>
<tr>
<td>NT$ 60 ~ 80 thousands</td>
<td>67</td>
<td>13.6</td>
</tr>
<tr>
<td>&gt; NT$ 80 thousands</td>
<td>44</td>
<td>8.9</td>
</tr>
<tr>
<td>Years of driving</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt; 1 year</td>
<td>40</td>
<td>8.1</td>
</tr>
<tr>
<td>1 ~ 3 years</td>
<td>63</td>
<td>12.8</td>
</tr>
<tr>
<td>4 ~ 6 years</td>
<td>85</td>
<td>17.2</td>
</tr>
<tr>
<td>7 ~ 9 years</td>
<td>60</td>
<td>12.2</td>
</tr>
<tr>
<td>&gt; 10 years</td>
<td>245</td>
<td>49.7</td>
</tr>
<tr>
<td>Trip purpose</td>
<td></td>
<td></td>
</tr>
<tr>
<td>working</td>
<td>113</td>
<td>22.92</td>
</tr>
</tbody>
</table>
4.3 SEM Results

Confirmatory factor analysis should first be processed to validate the measurement model with manifest variables before proceeding to the path analysis for latent variables. The evaluation of the goodness-of-fit of the measurement model should examine several indices, such as the ratio of chi-square to degrees of freedom ($\chi^2/df$), goodness-of-fit index (GFI), adjusted goodness-of-fit index (AGFI), standardized root mean square residual (SRMR), normed fit index (NFI), non-normed-fit index (NNFI), and comparative fit index (CFI). The goodness-of-fit indices for the measurement model are summarized in Table 4.

<table>
<thead>
<tr>
<th>Fit statistics</th>
<th>$\chi^2/df$</th>
<th>GFI</th>
<th>AGFI</th>
<th>SRMR</th>
<th>NFI</th>
<th>NNFI</th>
<th>CFI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Value</td>
<td>3.376</td>
<td>0.94</td>
<td>0.91</td>
<td>0.060</td>
<td>0.93</td>
<td>0.93</td>
<td>0.95</td>
</tr>
</tbody>
</table>

Researchers have recommended using the ratio of chi-square to the degrees of freedom ($\chi^2/df$) lower than 5.0 to indicate a reasonable fit (Marsh and Hocevar, 1985; Joreskog and Sorbom, 1993). The GFI, AGFI, NFI, and NNFI values of 0.90 or higher are considered evidence of good fit (Bentler and Bonett, 1980; Bentler, 1982). The SRMR would be smaller than 0.08 (Huang, 2002), and the CFI would be larger than 0.95 (Bentler, 1988). As the standard of fit indices mentioned above, we can conclude that the constructs in this model fits the sample data fairly well.
The causal relationship between these constructs would be confirmed in the structural model. Figure 4 presents the results of path analysis, and all path coefficients in the structural model are statistically significant at $p<0.001$ level. Drivers’ perceived value positively and directly affects their usage attitude toward real-time traffic information, and both perceived value and usage attitude positively relates to drivers’ compliance rate for enroute switching suggestion. Besides, drivers’ switching barrier and their congestion tolerability negatively and directly influences drivers’ compliance rate. The results of path analysis verify five hypotheses (i.e. $H_1$–$H_5$) that are assumed in structural equation model (shown in Figure 1).

It deserves to be mentioned that switching barrier and congestion tolerability have greater negative effects on drivers’ compliance rate than positive effects from perceived value and usage attitude. Thus, we can conclude that the effects of revealed traffic information provided to drivers can not play a dominant role on drivers’ enroute switching intentions (i.e. their compliance rate). Therefore, we should make more efforts to provide suitable and acceptable real-time information for drivers. Consequently, in the next section we will explore the enroute switching reaction of drivers under various hypothetical information scenarios.

5. BINARY LOGIT MODELING

The estimation results of the binary logit model are listed in Table 5. We compare two situations with considering latent variables or not in order to confirm the validity of latent variables in the behavioral model. As the results shown in Table 5, the explanatory ability of Model II is superior to Model I with considering latent variables. Most variables are statistically significant in these binary logit models, hence these explanatory variables play an
important role in drivers’ enroute switching behavior. The estimated coefficient for the constant term is negative, and it indicates that drivers would not likely switch to the alternative route while only receiving travel speed information for the regular route (i.e. information Scenario 0 shown in Table 3).

Drivers’ route switching rates will increase while providing more detailed information (i.e. information Scenario 2, 3, and 4 are shown in Table 3), especially relating to the alternative route. The estimated coefficients of the variables dummy 2, dummy 3, and dummy 4 correspond to information Scenario 2, 3, and 4, respectively. The values of the estimated coefficients of the four information scenario dummy variables increase from dummy 1 through dummy 4, so the variable dummy 4 has the highest value of all dummy variables.
Thus, the more richness of traffic information on the alternative route will enhance the enroute switching rates. Drivers would comply with enroute switching suggestion while providing more detailed information concerning the alternative or comparing the traffic situation of the regular route with the alternative route.

The latent variables perceived value, usage attitude, compliance rate, switching barrier, and congestion tolerability are extracted and identified using the structural equation model. According to the estimated coefficients list in Table 5, drivers would be likely to switch routes on the road while the latent variables perceived value, usage attitude, or compliance rate increase. On the contrary, while the switching barrier or congestion tolerability increases, this would reduce drivers’ propensity to switch routes. It is important to note that the magnitudes of the estimated coefficients of the negative variables (i.e., switching barrier and congestion tolerability) are greater than the positive variables (i.e., perceived value, usage attitude, and compliance rate). Hence, we should provide better information quality (such as information Scenario 3 and 4) to drivers in order to overcome the negative impacts from the latent variables switching barrier and congestion tolerability.

Finally, the results show that several socioeconomic and travel characteristics are also significant in the binary logit model. Drivers are female, younger, higher education background, or less years of driving experience might be likely to switch routes under the provision of information scenarios. Drivers who are familiar with the alternative route, frequently driving on freeway, or often encountering congestion on freeway would be also likely to switch routes. The causes might be attributed to their inherent personal characteristics or richer experiences.

6. CONCLUSION

An on-line questionnaire survey was conducted in the Taipei metropolitan area of Taiwan to explore the effects of latent variables and various information scenarios on drivers’ enroute switching behavior. The latent variables were extracted and identified using the structural equation modeling process. As a result the variables perceived value and usage attitude have a positive influence on compliance rate, but otherwise the variables switching barrier and congestion tolerability have a negative and dominant influence on the compliance rate in the structural equation model. Five proposed hypotheses were also confirmed in the structural equation model.

It reveals several conclusions regarding the enroute switching behavior of freeway drivers in the binary logit model. The latent variables perceived value and usage attitude toward revealed traffic information could positively reinforce drivers’ compliance rate while the
switching barrier and congestion tolerability could negatively restrict them. Although the negative latent variables switching barrier and congestion tolerability would dominate drivers’ enroute switching behavior, we can offer better information quality to offset the negative restriction on drivers’ intentions while they encounter traffic congestion on the road.

The results indicated that drivers are most likely to switch routes while receiving more richness information scenarios especially relating to the alternative route. While providing more detailed information on the alternative route or comparing the traffic situation of the regular route with the alternative route (i.e. information Scenario 3 and 4) may encourage drivers to change their travel decisions and comply with the diversion suggestion. If the improvement on the advanced driver information system could be implemented, drivers would have more confidence in the information content they receive. This insight may help to offer some suggestions for the management strategy of freeway information systems in Taiwan. Further study could consider other scenarios of information for the proposed model, and more relevant factors could be collected to explain drivers’ enroute switching behavior. More congestion situation can be also simulated to discuss drivers’ possible diversion reactions using the experimental approach.

**REFERENCES**


Research Record, Vol. 1676, 53-60.


